Monthly report No. 2
Fabrication of long wavelength array by in-situ molecular beam epitaxy
(contract No. DAAB07-91-C-K762)

1.0 Summary of progress

During this reporting period, we have completed the preparation of remaining effusion cells and associated fixtures. The molecular beam fluxes of the source materials (In, Sb, and As) have been calibrated with respect to cell temperatures. The optimized process of fluoride buffer epilayer has been started and is underway. In addition, we have designed the sample and mask carriers for the array fabrication by in-situ MBE.

2.0 Flux calibration of In, Sb, and As

To construct the InAsSb long wavelength IR (LWIR) detector structure, the composition ratio (As/Sb) and the growth rate need to be precisely controlled during the MBE growth. In this period, we have measured the beam equivalent pressure of the three source materials (In, Sb, and As) at different temperatures by placing a nude ion gauge at the sample position. The calculated molecular beam fluxes and fitted curves are plotted against cell temperature in Fig. 1. The shadow area shows the flux regime suitable for the InAsSb epilayer growth.

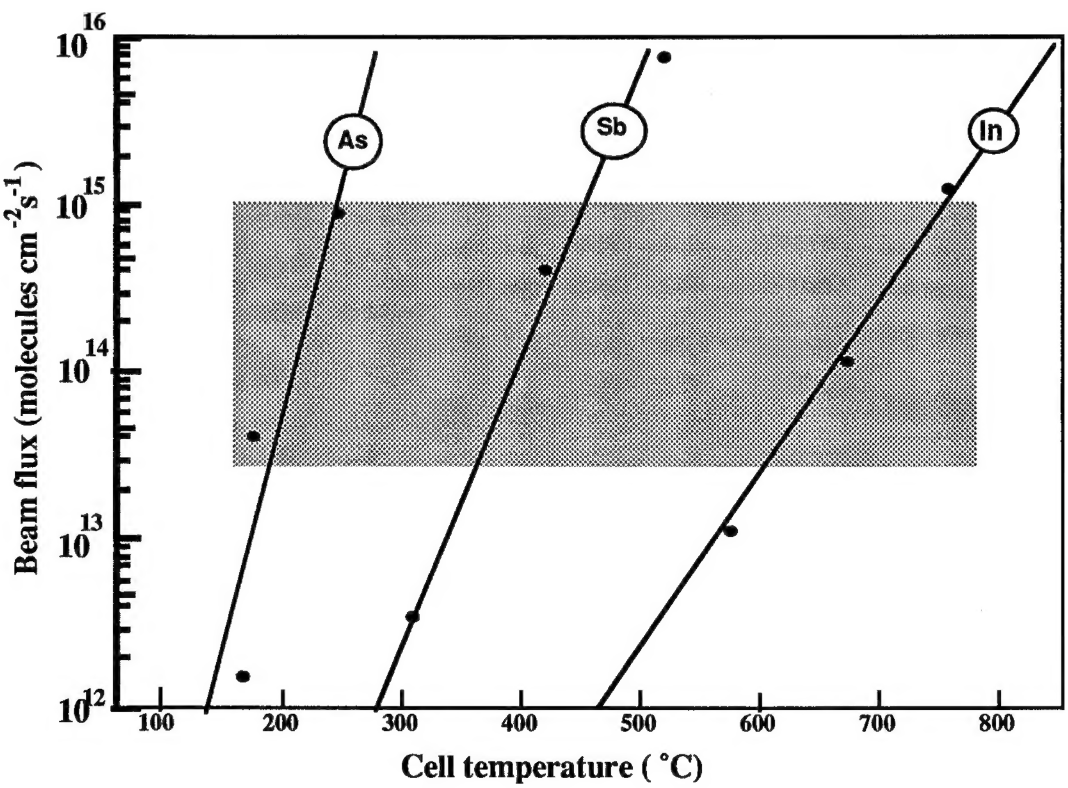


Fig. 1 Beam flux of In, As, and Sb vs. effusion cell temperature

3.0 Fluoride growth on Si substrates

The crystal quality of stacked BaF_2(2500Å)/CaF_2(500Å)/Si has been examined by X-ray diffraction. The result is shown in Fig. 2. The unresolved Si and CaF_2 peaks are mainly due to the close lattice constant (0.4% difference) between them. The single sharp BaF_2(111) peak shown in Fig. 2 proves the single crystal growth of the fluoride epilayer. To achieve a good quality InAsSb detector, the optimization of the fluoride buffer epilayers is important. We have designed and grown three different buffer layer structures (Fig. 3). The results of the evaluation of the test structures will be presented and discussed in following reports.

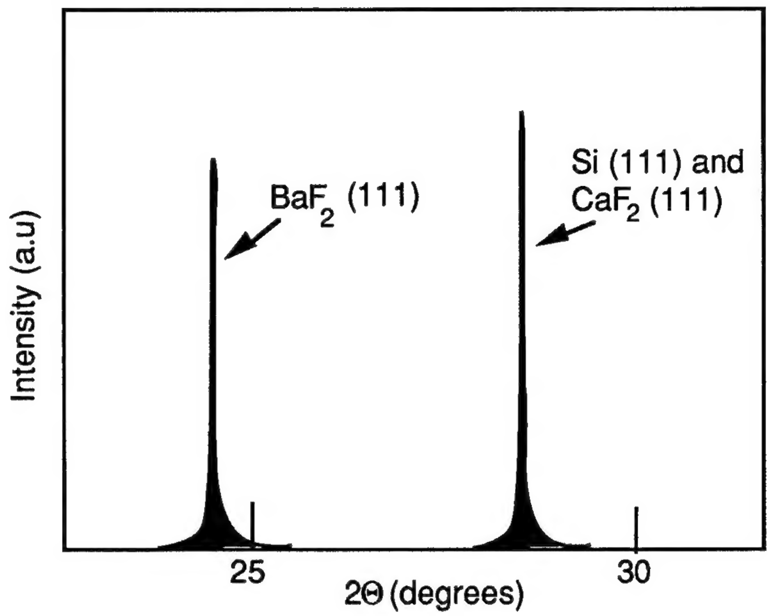


Fig. 2 XRD result of BaF_2(2500Å)/CaF_2(500Å)/Si epilayer

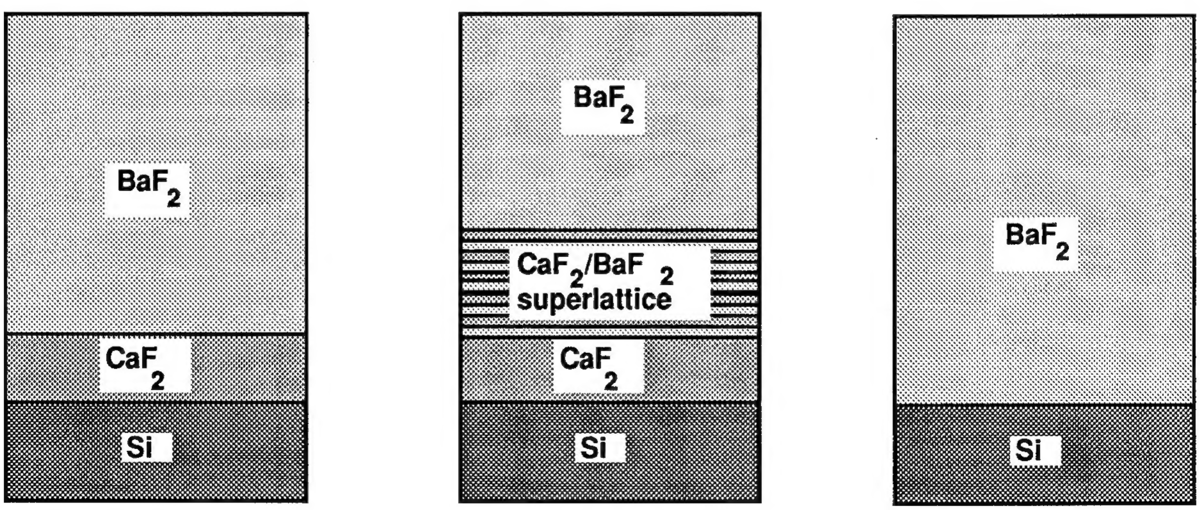
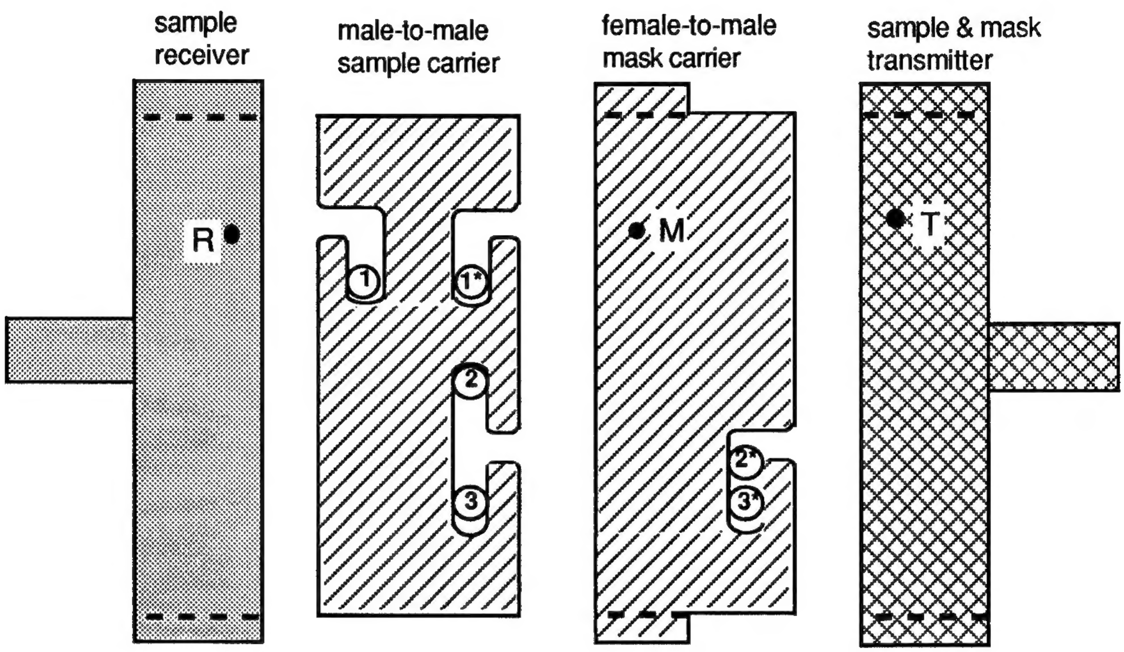


Fig. 3 Schematic diagram of stacked fluoride test structure grown on Si substrates

4.0 In-situ sample and mask transfer design

The last required task during this period is to design the transfer procedure for the sample and mask carriers for the in-situ array fabrication (Fig. 4). The transfer of the sample and mask carriers has been successfully demonstrated outside the MBE system. The metal mask design for delineating the LWIR array by in-situ MBE is currently underway. The final design will be presented in future reports.



Step	Engagement	Rotation	Action
#1	R + 1 + 1* + T	Clockwise	Sample carrier loading
#2	R + 1 + 2 + M + 2* + T	Clockwise	Mask carrier loading
#3	R + 1 + 3 + M + 3* + T	Counterclockwise	Sample and mask carrier unloading

Fig. 4 Sample and mask carriers and corresponding transfer procedures

5.0 Conclusion

In this period, the MBE effusion cells for In, Sb, and As sources have been constructed and tested. The stacking fluoride epilayers on Si substrates have shown good control in the MBE growth. Further optimization on the crystal quality of the fluoride epilayer is underway. The transfer procedures of the sample and mask carriers inside the MBE system have been demonstrated. The tasks for next period will be the optimization of the fluoride buffer layer, delineation of the InAsSb growth, and the mask design.